ECONOMIC EVALUATION OF ENVIRONMENTAL POLICY

Dr. Thomas Gunton, Director
School of Resource and Environmental Management
Simon Fraser University
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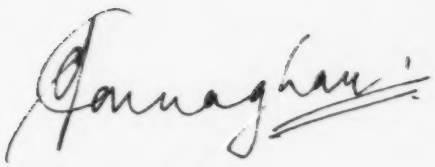
PREFACE

Economic Evaluation of Environmental Policy was prepared by Dr. Thomas Gunton, Director of the School of Resource and Environmental Management and Simon Fraser University, at the request of the British Columbia Round Table on the Environment and the Economy. It is part of a series of background reports dealing with issues which the Round Table considered important to the development of a sustainable development strategy in British Columbia. It is intended to provide information that will assist the dialogue between the Round Table and the public.

The Round Table has endorsed this report. The information provided and conclusions reached in this document are those of the author.



C.J. Connaghan
Chairman
British Columbia Round Table on the
Environment and the Economy

EXECUTIVE SUMMARY

Economic Evaluation of Environmental Policy

This background report focuses on the economic evaluation techniques available to help interest groups and decision makers to better understand the impacts of environmental policy options.

The report begins with an argument that economic evaluation techniques must be complemented by institutional structures which ensure broad public participation in the decision making process. The decision making process is described as a sequence of steps: goals and objectives must be identified, options evaluated and the preferred option chosen and implemented.

The author then reviews four economic techniques for evaluating environmental policy: benefit-cost, cost effectiveness, economic impact and multiple objective analysis. The advantages and disadvantages of each technique are described. A case study is provided to illustrate the points made.

It is noted that economic evaluation is underutilized in British Columbia. A number of recommendations are made which encourage the use of economic analysis. Suggestions are also made for improving and integrating provincial data and economic models required for economic evaluation of environmental policies.

The overall conclusion of the report is that economic evaluation can improve resource and environmental management in British Columbia.

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Contents

1.0. Introduction 1

2.0 The Decision Making Process 2

3.0 Benefit-Cost Analysis 3

4.0 Cost-Effectiveness Analysis 7

5.0 Economic Impact Assessment 8

6.0 Multiple Objective Analyis 10

7.0 Measuring Non-market Values 14

7.1 Market Reliance 15

7.2 Contingent Valuation Method (CVM) 16

7.3 Travel Cost Method (TCM) 24

7.4 Hedonic Price Method 27

8.0 Case Study 28

9.0 Conclusion 35

Bibliography 39

Appendix 1. Supporting Tables 50

1.0 INTRODUCTION

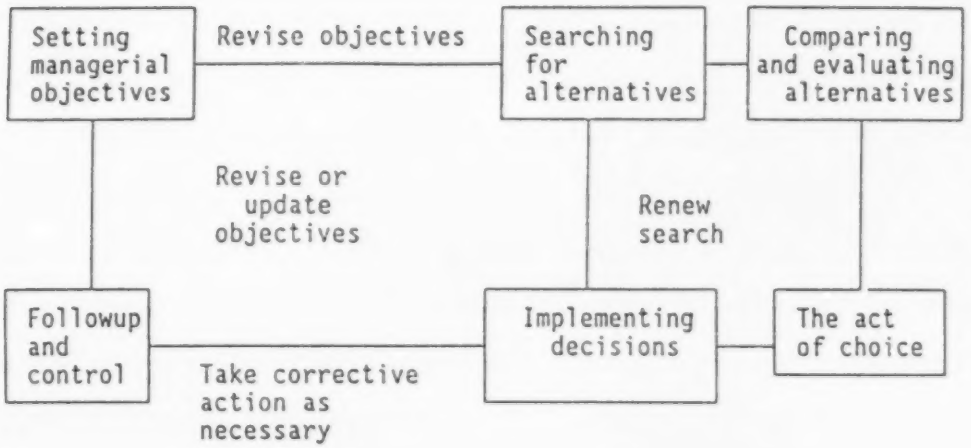
In 1987, the World Commission on Environment and Development published Our Common Future. The report cogently summarized the major problems threatening the long run health of the planet and called for a new approach to development to secure a livable future. This new approach termed sustainable development was defined by the Commission as "meeting the needs on the present without compromising the ability of future generations to meet their own needs" (WCED, 1987:8). The thrust of this approach is to ensure that environmental concerns are integrated into the decision making process. Environmental values such as clean air, clean water, wilderness and life support systems such as the ozone layer must be viewed as essential to a healthy economy. The challenge in environmental analysis is to carefully assess environmental and economic tradeoffs to ensure that decision makers are fully cognizant of the consequences of alternative policies.

The objective of this paper is to assess economic techniques for evaluating environmental tradeoffs. The paper begins with an introduction to the decision making process followed by a review of techniques for assessing tradeoffs including benefit-cost, cost effectiveness, economic impact assessment and multiple accounts analysis. Non-market valuation is especially important given the tendency to exclude important environmental values such as wilderness, clean air and water simply because their are no readily available market prices. The paper includes a detailed discussion of methods for assessing non-market values. A case study is used to illustrate the application of the techniques to land use planning.

2.0 THE DECISION MAKING PROCESS

Decision making is normally described as a process involving a sequence of steps. Goals and objectives are identified, options are evaluated and the preferred option is chosen and implemented. Impacts are then monitored to measure the success of the management strategy. The process is continuous as strategies are revised in light of changing circumstances. The process is summarized in Figure 1.

Figure 1



In Canada many decisions are made by private sector firms operating in the market. Governments are responsible for developing policies and regulations to ensure that public impacts or "spillovers" which may not be considered by private firms are incorporated into the decision making process. The evaluation of options by the public sector must therefore go beyond the narrow financial analysis used by private sector firms and include public or social values important to society at large.

It is important to emphasize that decision making is inherently a political process that involves tradeoffs between competing values held by diverse interest groups. Economic evaluation cannot resolve these tradeoffs. Instead, economic analysis merely helps relevant interest groups to understand the impacts of policy options. Economic evaluation must be complemented by institutional structures which ensure broad public participation in the decision making process.

3.0 BENEFIT-COST ANALYSIS

Benefit-cost analysis has been widely used in policy and project evaluation for a number of decades. The elements of the method are outlined in a number of manuals (BC 1977; Canada, 1976) and texts (Sugden and Williams, 1978; Pearce and Nash, 1981). Stanbury, Vertinsky and Thille (1990) provide a recent summary of the application of benefit-cost analysis to forest planning.

Benefit-cost analysis begins with identification of alternative projects or management plans. All major impacts on society of each alternative are itemized and, where possible, quantified in dollars. Quantifying of project benefits is normally based on consumers' willingness to pay for the goods or service being produced while costs are based on "opportunity cost", defined as the benefits that could be generated in the next best alternative use of the labour and capital to be consumed in the project being evaluated.

Benefits are usually based on the market price of project outputs and costs on the market price of inputs. If there are market imperfections such as externalities (costs or benefits accruing to those not involved directly in the project) or monopolies, or if the cost or benefit is an intangible, such as recreation, for which there are no market prices, "shadow prices" (defined as the hypothetical price in a perfectly functioning market) must be used.

Due to uncertainty in forecasting future prices and in estimating shadow prices, sensitivity analyses are normally done using a range of probable values.

In general, society values a dollar's worth of benefits and costs less the further into the future they occur. So that benefits received and costs incurred at different times are comparable, they are adjusted by discounting to their present value. There is little agreement on what rate is appropriate for discounting future values, and therefore a sensitivity analysis is usually undertaken using a base case rate as well as higher and lower rates. After benefits and costs are discounted, total costs are deducted from total benefits to identify the net present value (NPV). If the NPV of the project is positive, benefits exceed costs and the project is deemed to be in the public interest. If competing projects are being evaluated, the one with the highest net present value is normally preferred (Canada, 1976:31).

The principal advantage of benefit-cost is that it attempts to incorporate all major impacts including environmental effects into a consistent analytical framework based on common units of measurement which can be summed to provide an overall assessment of the tradeoffs for decision makers. It therefore goes beyond the narrower financial analysis employed in private sector evaluations. As Pearce and Nash (1981:4) conclude:

> CBA [cost-benefit analysis] at least forces the process of evaluation to list all gains and losses and to weigh their relative values. This may seem a small virtue. But in a world where decisions are made more often than not on irrational assessments, it could remain the single most important attribute of any calculus designed to assist the decision-making process.

Benefit-cost also has weaknesses. One major criticism is that the dollar values used are based on consumers' ability to pay, not their willingness to pay. In effect, benefit-cost uses a decision formula in which one dollar equals one vote, an approach contrary to the

principle of democratic society. This problem can be mitigated by weighting impacts on lower income people more heavily than those on the wealthy. This is in practice difficult to do and controversial among analysts (Pearce and Nash, 1981:27-38). Suffice it to say that benefit-cost inevitably reflects the preferences of the wealthy more than those of the poor.

Another major problem is that the dollar value of many important resources such as wildlife, wilderness, air and water is not easy to determine because these resources are not bought and sold in the market place. Analysts must use other methods which will be discussed later in this paper to estimate an appropriate dollar value. In practice this is difficult. When it is done, decision makers often reject the results, concluding that because the dollar values are simulated by non-market techniques, these resource values are inferior to resources such as timber which are traded in the market place. Further, because people value economic losses more than gains, economic valuation based on willingness to pay understates environmental values (Knetsch, 1990). Consequently, important resource values are commonly ignored or underestimated in benefit-cost analysis.

When market prices are readily available, there are still problems. Markets are subject to numerous imperfections which mean that the market price does not reflect the true benefit or cost to society. Timber prices, for example, may not include the social cost of foregone fisheries values caused by the destruction of fish habitat. Using timber prices as measure of the benefit of logging would could then overstate the benefit. Conversely, timber prices may understate the social benefit of logging if the workers employed in logging would otherwise be unemployed. In this case the opportunity cost of labour, defined as the value of labour in its next best use, would be closer to zero and the true social cost of timber production would be lower than indicated by the market wages.

Although benefit-cost analysts attempt to mitigate these problems by adjusting market prices to compensate for imperfections, the adjustments are controversial and difficult to make. Consequently, analysts have to employ a range of values through a sensitivity analysis with the result that there is a wide range of final net benefit estimates with no certainty as to which estimate most accurately reflects the true value. This problem is exacerbated by the necessity to forecast market prices over the life of the project. Timber prices, for example, have to be forecast over the next several decades to estimate the value of a timber harvesting operation. The forecast price is normally the most significant variable affecting the final net benefit estimate. Small changes in the forecast cause wide variations in the net benefit estimate. Given the volatility in commodity prices, such forecasts and consequently net benefit estimates are notoriously unreliable.

Another key limitation is that some variables which are important to decision makers, such as employment and income distribution, cannot be properly incorporated into a benefit-cost framework because they are inconsistent with benefit-cost methodology. Employment generation, for example, is not generally counted in benefit-cost analysis because it is assumed that most of the labour employed in a project would be employed elsewhere in the economy if the project did not go ahead. If there are unemployed resources in the economy, provision can be made for including indirectly some of the employment creation benefit by using a lower wage rate to increase the overall net benefits of the project. However, the actual job creation impacts are not explicitly identified. Consequently, the decision maker interested in employment impacts of a project on a small region will not find benefit-cost analysis helpful. As a result, benefit-cost often has little influence on the final decision.

A final concern is that benefit-cost analysis has too short a time horizon. Discounting effectively excludes impacts occurring beyond several decades. A dollar's worth of benefits

or costs incurred in 50 years is only worth 3 cents in a benefit cost calculation assuming a modest 5% discount rate. Consequently, the costs of disposing nuclear waste after the closure of a nuclear power plant or the benefits of replanting trees would have little weight in a benefit-cost analysis. Due to lack of agreement on theoretical and practical issues, most analysts recommend using a range of rates. The Government of Canada recommends, for example, using a range between 5% and 15% (Canada, 1976:26) while the B.C. government recommends rates between 8% and 12% (BC, 1977). Again, the choice of rates can significantly affect the results. Given the lack of agreement on the appropriate rate, there will be a lack of agreement on which result is most valid.

Benefit-cost has been utilized in diverse resource and environmental decisions in B.C. ranging from the development of the northeast coal project, the Vancouver Island pipeline, the Site C hydro dam and land use conflicts. Guidelines for benefit-cost analysis were developed by the provincial government in 1977 (BC, 1977). Overall, however, benefit-cost analysis has been under-utilized in B.C. Further, as a summary in Table 4 of Appendix 1 shows, benefit-cost studies in B.C. have used a wide range of assumptions and approaches. This has significantly reduced the reliability and comparability of the results.

4.0 COST-EFFECTIVENESS ANALYSIS

Cost-effectiveness analysis is a variant of benefit-cost which is used when it is not possible to estimate the dollar value of benefits. The steps are similar to benefit-cost. The desired objective or benefit such as reducing pulp mill effluent is identified and a quantitative measure such as tonnes of discharge is chosen. Options for achieving the desired objective are identified and costed in dollars. A cost-effectiveness ratio is then estimated for each option by dividing the reduction in tonnes of discharge by the dollar cost. The options can

then be compared on the basis of their relative cost per tonne of effluent reduction. The most efficient option is the one with the largest reduction per dollar spent.

The objective of cost-effectiveness analysis is to ensure the most efficient expenditure of funds to achieve the desired objective. The analysis can be structured to minimize the cost of achieving a given environmental objective such as a 50% reduction in pulp mill effluent or to maximize the effectiveness of a given budget allocation by identifying the option or combination of options which achieves the highest attainment of the desired objective. The advantage of this approach relative to benefit-cost is that it can be used in instances where it is not possible to quantify the policy objectives in dollars and where alternative objectives such as employment are considered important in the analysis. Cost-effectiveness, then, is more flexible. The disadvantage is that because the benefits are measured in different units than the costs, it is not possible to show whether the benefits exceed the costs and therefore whether the policy is worth undertaking. It simply identifies the best means for achieving the objective.

5.0 ECONOMIC IMPACT ASSESSMENT

Economic impact assessment is a technique for determining the impact of a policy or project on selected economic indicators such as employment, gross economic output and government revenue. The techniques are outlined in a number of texts (Davis, 1990) and manuals (Schwartz, 1982). Recent applications in B.C. include an economic impact assessment of the northeast coal project (B.C., 1981) and the implementation of wilderness withdrawals on the B.C. economy (M'Gonigle, Gunton, et al., 1990).

The first step is to identify the direct economic impacts of the project including the value of production and number employed. Next the indirect impacts defined as the purchase of

inputs such as equipment and supplies by the project are identified by source. Finally the induced impacts defined as the effect of the purchases of those employed in the project, such as food and retail services, are estimated. The indirect and induced effects are normally estimated by an economic multiplier model or an input-output model which traces the linkages through the economy. A tax model can be integrated to estimate the impacts on government revenue.

The conceptual framework of economic impact assessment is fundamentally different from benefit-cost. In benefit-cost it is assumed that if the capital and labour employed is not employed in a given project, it will be employed elsewhere in the economy. The economy simply expands to employ most people wanting a job at the prevailing wage rates. There are of course instances in which the economy is not at full employment and not all labour to be employed in the project will find alternative employment if the project does not go ahead. In instances where the economy is not at full employment, benefit-cost analysis uses a shadow price for otherwise unemployed resources which measures the job creation benefit. The important point, however, is that even if there is unemployment in the economy, most of the jobs created are not incremental jobs; they simply displace other jobs which would be created in other projects which would go ahead if the project in question does not. The same holds true for government revenue. Tax revenue generated by a specific project is not incremental revenue. In the absence of the project, capital and labour would be employed in other projects generating comparable revenue

What then is the role of economic impact assessment in project evaluation? From the perspective of the larger economic unit such as Canada, most of the jobs are not incremental. From the perspective of a smaller economic unit such as Prince George or Vancouver Island the jobs generated by a project are incremental because if that project does not go ahead, the capital and labour that would have been used in that project will

likely not be employed in Prince George or Vancouver Island. Instead, the labour will be employed in alternative projects outside the region. Therefore, economic impact assessment is useful at the regional level for assessing incremental economic impacts.

Nonetheless, economic impact assessment is likely the most misused technique for policy and project evaluation. It is often assumed that **all** economic impacts are incremental and that economic impacts alone justify a project. Government revenue analysis is particularly abused by including all the tax revenue generated by a project but excluding most of the general public expenses such as education and health services necessary to serve those employed in the project. While it is true that these services would have to be provided regardless, they would not have to be provided in the region or province if the project did not go ahead and the labour was ultimately employed elsewhere outside the region. And if the labour was employed elsewhere in the region, comparable tax revenue would be generated.

Although the results could be affected by lags in economic adjustments and abnormal expense and revenue flows unique to the project, new tax revenue from a project is normally offset by new public costs with the result that net tax revenue is normally close to nil.

6.0 MULTIPLE OBJECTIVE ANALYSIS

The multiple objective approach is based on the assumption that economic, social and environmental factors should all be given weight in decision making and that these different factors cannot be effectively integrated into one grand index such as a benefit-cost ratio. Indeed, decision makers are interested in seeing the effects of policies disaggregated so that they can identify impacts on the variables most significant to them.

A number of different techniques have been developed to undertake multiple objective analysis. One common approach is the goals achievement matrix in which options are listed on one axis and objectives on the other (Hill, 1978; McAllister,1980). Each option is then rated in terms of its ability to meet the objective or criterion. A related approach is the planning balance sheet (Lichfield, Kettle and Whitbread, 1975; McAllister, 1980).

The most comprehensive effort to develop a multiple objective approach for environmental planning is the development of the **Multiple Accounts Analysis Guidelines** in the United States by the U.S. Water Resources Council. In October 1961, the U.S. Secretaries of the Interior, Agriculture, Army, and Health, Education and Welfare were requested to review evaluation standards for the use and development of water and related land resources, and to recommend improvements. After considerable background work, recommendations were set forth in the Report to the Water Resources Council by Special Task Force: Procedure for Evaluation of Water and Related Land Resource Projects (1969), and officially adopted by the U.S. Water Resources Council (WRC) on October 25th, 1973 when the WRC's Principles and Standards for Planning Water and Land Related Land Resources (1973) became effective under the authority of the Water Resources Planning Act of 1965 (O'Brian, 1977:4). The methods were revised in 1979 and subsequently referred to as the "Principles, Standards, and Procedures" (PS&P) (Deason, 1982:39) after 1980. However, the PS&P were repealed in 1982, and then reincarnated in 1983--albeit downgraded to the status of "Guidelines" (Grigg, 1985:80-83). The 1983 incarnation, Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G), is currently in use. A similar approach was developed in Canada by the Canadian Department of Fisheries and Oceans (Canada, 1988), by B.C.Hydro for the Revelstoke Dam Project (Reid, 1976) and for the B.C. Ministry of Lands, Parks and Housing (1979) for crown land management.

The U.S. Water Resources Council guidelines propose the creation of four separate accounts to analyze proposed project impacts on the economy, environment and social well-being. The four accounts currently utilized are:

1) National Economic Development Account (NED),
2) Environmental Quality Account (EQ),
3) Regional Economic Development Account (RED), and
4) Other Social Effects Account (OSE).

The NED account is in essence a traditional benefit-cost analysis designed to identify the plan with the greatest net economic benefit to society.

The EQ account is reserved for only those environmental impacts which cannot be monetized. Other environmental impacts which can be monetized are incorporated in the benefit-cost analysis in the NED account. The principal environmental factors included in the EQ account are ecological, cultural and aesthetic attributes. Ecological attributes include functional aspects of the environment (e.g., assimilative capacity, erosion, nutrient cycling, succession) and structural aspects such as plant and animal species, chemical and physical properties of air, water and soil (e.g. pH of rainfall), and so on. Cultural attributes are evidence of past and present habitation that can help in understanding and propagating human life. Aesthetic attributes include sights, scents, sounds, tastes, and impressions of the environment.

It is clear that these attributes would be difficult to measure in monetary terms, although they can be measured in other ways. These include both quantity indicators that employ numeric scales and quality indicators that use non-numeric scales, such as "good" and "bad".

It is obvious, however, that the EQ attributes must be presented in a clear and concise fashion to be useful in the decision making framework.

Several principles govern the planning process with respect to the EQ account. Both an interdisciplinary approach and public involvement are required in the planning process, although the means for involving the public is left at the discretion of the government agency. Further, as in the case of NED costs and benefits, the EQ attributes need to be displayed in a way that highlights the comparison between the "with project" and "without project" scenarios.

Regional economic development benefits are an important component of project evaluation in both Canada and the United States. As discussed previously, economic development impacts cannot be effectively integrated into a benefit-cost framework. The RED account addresses these concerns by explicitly utilizing two measures of the effects of the plan on the regional economy: regional income and regional employment. Regional income is measured in dollars and regional employment in person-years of employment.

The OSE account includes any items not included in the other three accounts but that are important for planning. While the U.S. WRC's P&G provides no procedures for evaluating other social effects, it does indicate that such effects include urban and community impacts; life, health, and safety factors; displacement; long-term productivity; and energy requirements and energy conservation. They also include effects on income distribution, employment, population distribution, the fiscal condition of state and local governments, quality of community life, and so on. While some of these effects can be measured in monetary terms and included in the NED account, others need to be displayed using guidelines similar to those of the EQ account.

Once the separate accounts have been constructed, the relevant information is then displayed in a single matrix indicating impacts on relevant variables with and without the project. The decision makers then compare the plan options and choose the one that maximizes NED subject to environmental, social and regional development constraints summarized in the other accounts.

7.0 MEASURING NON-MARKET VALUES

A major challenge in all economic approaches is estimating the value of intangibles such as wilderness, air and water for which there are no observable prices. Conceptually, intangible environmental values can be divided into two broad categories: use value and preservation value. Use value is the value derived from the present or anticipated direct physical use of the resource. Use values include activities such as logging, fishing, wilderness hiking, and scenic viewing.

Preservation values involve indirect use of the resource. Preservation values can be further subdivided into existence value and option value. Existence value represents the value derived by people knowing that something exists even though they have no interest in utilizing it themselves (Krutilla and Fisher, 1975). People may derive satisfaction by knowing that others are utilizing a resource (vicarious existence value), that the resource is being preserved for future generations (bequest existence value) or that the resource is being well managed (stewardship existence value). Option value is the value derived from a land use decision which leaves future options open. Irreversible decisions such as logging a unique wilderness area, for example, should be discounted relative to reversible decisions.

Recent attempts to estimate preservation values for wilderness suggest that they are of significant magnitude (Walsh and Loomis, 1989). However, preservation values are often excluded from benefit estimates because they are more difficult to measure than use values. The exclusion of preservation values, therefore, can result in a significant underestimate of land use benefits.

Economists have developed several methods for estimating non-market values. These approaches include: market reliance, contingent valuation, travel cost and hedonic price analysis.

7.1 Market Reliance

One approach for valuing non-market resources is to create a well functioning market to establish a market price and allocate the resource through normal private market transactions. Values for hunting and fishing, for example, can be established by charging users and/or privatizing the resource to allow private sector entrepreneurs to market and manage the commodity. Crown land in B.C. could also be privatized to allow allocation to the highest bidder.

The use of markets is an important tool in achieving environmental objectives. The problem, however, is that it is difficult to create markets. How does one charge residents for a scenic view or clean air? Even when there is a market such as for agricultural land or timber, the market prices do not adequately reflect the true social value of the resource because of numerous market imperfections such as externalities. Agricultural land prices may understate social value because they exclude the scenic value of agricultural land. Timber prices may understate timber values because pulp prices, a byproduct of timber, may be artificially deflated by the market power of pulp mills or intra-company accounting.

Consequently, even if it was possible to create markets for all natural resources, market prices would still have to be adjusted to ensure that they reflected all the costs and benefits to society.

7.2 Contingent Valuation Method (CVM)

One of the most popular techniques for estimating non-market values, such as wilderness protection, is the contingent valuation method (CVM). CVM attempts to simulate market behavior by asking consumers through a social survey what they would be willing to pay for a good or service. The value of the good is estimated by multiplying the average willingness to pay by the number of consumers.

The method was first used by Davis (1963) to estimate the benefits of outdoor recreation in the United States. Since Davis's pioneering work, CVM has been utilized to measure a diversity of public goods including recreation (Walsh, Miller and Gilliam, 1983), hunting (Sorg and Nelson, 1986), fishing (Sorg et al., 1985), wilderness preservation (Walsh, Loomis and Gillman, 1984), and environmental quality (Jackson, 1983).

The extensive research on CVM has resulted in its widespread acceptance and credibility as a method for estimating non-market values. Research by Randall et al. (1974), Hoehn and Randall (1987) and Cummings et al. (1986) supports the theoretical basis of CVM. Various manuals and guidelines employed by government agencies recommend the use of CVM in project evaluation. Commencing in 1979, for example, the US Water Resources Council (1983) included CVM as an appropriate technique for estimating project costs and benefits. The US Army Corps of Engineers now uses CVM in a number of its project evaluations and has recently published a handbook on CVM (Moser and Dunning, 1986). CVM is also accepted as an appropriate method for measuring benefits and damages under

the U.S. Environmental Response, Compensation and Liabilities Act (1980) and in civil litigation. In British Columbia, CVM is a recommended technique in the province's Guidelines for Benefit Cost Analysis (1977) and has been utilized in numerous project evaluations, largely in hydro development.

Although the concept underlying CVM is relatively simple, a number of different survey approaches have been developed to elicit consumer responses. The simplest technique is an open-ended question asking people what they are willing to pay for the public good. This approach has been criticized because respondents often do not have sufficient information or experience to accurately estimate the value. Further, this approach does not simulate market behavior very well. In normal markets, people are presented with a good for sale at a specific price, not a question of what they are willing to pay.

Another technique is the dichotomous choice method in which consumers are asked whether they would pay a specific price or not. Advocates of this approach argue that it better simulates real market transactions in which people either purchase or don't purchase goods at the stated selling price (Bishop et al., 1986; Bowker and Stoll, 1988). This approach is more expensive because it requires a larger number of observations to achieve the same level of statistical reliability as the other techniques (Mitchell and Carson, 1989).

A third technique developed by Randall et al. (1974) is an iterative bidding process in which the consumer is asked whether he would pay a specific price for the good in question. If the answer is affirmative, the interviewer raises the amount by successive increments until the response is no. The amount is then lowered by smaller increments until agreement is reached. Advocates of iterative bidding maintain that it is easy for respondents to understand, given that it is based on a common auction process. Also, the iterative process gives respondents the opportunity to better contemplate their answers

(Hoehn and Randall, 1987; Cummings et al., 1986). The principal problem with this approach is that the starting point of the bidding can influence the respondents' answers (Roberts, Thompson and Pawlyk, 1985).

A more recent approach advocated by Mitchell and Carson (1989) is the payment card which provides respondents with a range of values on a single card. Some specific price data are often included, such as the cost of providing various public goods. The respondents are then asked to choose the value which best represents their willingness to pay. The alleged advantage of this approach is that it has the same advantages of iterative bidding, while overcoming the problem of the starting point bias. The method can still bias the result by the range of values provided on the card.

Advocates of CVM cite a number of advantages. First, CVM is consistent with the theory of individual choice and welfare measurement (Smith, 1987). Second, CVM is flexible. The technique can be modified to incorporate changes in quality, quantity, alternative payment mechanisms, market structures and types of tradeoffs related to most non-market situations. This flexibility is reflected in the wide application of CVM to different types of valuation problems ranging from expenditures on reducing risk to wilderness preservation. Third, CVM can incorporate non-user values such as option and existence values into the valuation. As discussed earlier in this paper, these values are significant.

There are, however, problems. CVM requires respondents to speculate on their behavior in hypothetical market situations. This can bias the results in several ways. Because respondents don't actually make a purchase, they lack the same incentive that they have in a normal market situation to undertake the research and contemplation required to give accurate responses (Freeman, 1979a). Responses may also reflect "strategic bias" if respondents alter their responses to influence the result. In forestry-wilderness tradeoffs,

for example, those in the forest industry have an incentive to understate their valuation of wilderness while wilderness preservationists have an incentive to overstate their value. Research also shows that the valuation of a non-market commodity may be affected by the method of payment specified in the survey (Greenly, Walsh and Young, 1985; Brookshire et al., 1981). Respondents, for example, may be willing to pay more for a good if the payment is made by an entrance fee instead of by a general tax increase. Responses can also be affected by the starting point and range used in the survey. This is especially true when the respondent is unfamiliar with the good and is consequently more likely to be influenced by the survey design.

A second issue is a inconsistency between willingness to pay and willingness to accept. Economic theory suggests that the amount consumers are willing to pay (WTP) for a marginal increase in consumption should be about the same as the amount they are willing to accept (WTA) as compensation for an equivalent decline in consumption. However, the research summarized in Table 1 shows that WTA amounts exceed WTP by a wide margin.

Should WTP or WTA be used in benefit estimates? Knetsch, one of the leading researchers in this area, suggests that WTP should be used when considering supplying more of something and WTA when withdrawing supply (Knetsch, 1984). Knetsch also emphasizes the importance of the general finding for policy that people value losses significantly higher than gains. Consequently, economic assessments can significantly understate environmental costs and lead to decisions biased against environmental values (Knetsch, 1990). Cummings et al. (1986:218) prefer WTP because WTA values are less stable and tend to converge towards WTP values during successive rounds of valuation. They caution, however, that WTA should not be rejected out of hand (Cummings et al., 1986:221). Suffice it to say that the use of WTP may significantly understate environmental values.

Table 1. Measures of WTP and WTA[a]

Study	WTP	WTA	WTA/WTP
Hammack and Brown (1974)	$247.00	$1044.00	4.2
Banford, Knetsch, and Mauser (1979/80)	43.00 22.00	120.00 93.00	2.8 4.2
Sinclair (1976)	35.00	100.00	2.8
Bishop and Heberlein (1979)	21.00	101.00	4.8
Brookshire, Randall, and Stoll (1980)	43.64 54.07 32.00	68.52 142.60 207.07	1.6 2.6 6.5
Rowe, d'Arge, and Brookshire (1980)	4.75 6.54 3.53 6.85	24.47 71.44 46.63 114.68	5.2 10.9 13.2 16.6
Coursey, Hovis, and Schulze (1987)	2.50 2.75	10.50 4.50	3.8 1.6
Knetsch and Sinden (1984)	1.28	5.18	4.0
Heberlein and Bishop (1986)	31.00	513.00	16.5

[a]All amounts are in year-of-study dollars.
Source: Fisher, McLelland & Schulze (1988:129).

A third and more serious problem with contingent valuation is the problem of sequencing and embedding. Tolley and Randall (1983) found, for example, that estimates of the value of improved air quality in the Grand Canyon varied by a factor of three depending on whether the question was asked before or after questions dealing with air quality in the residents' own city. Kahneman and Knetsch (1990) in a series of CVM valuations also show that the valuation of a commodity is significantly affected by whether the question is asked separately or in conjunction with other related commodities. The results show that respondents are willing to pay similar amounts for a narrowly defined good such as preservation of a single wildlife species in one park as they are for a more inclusive good such as all wildlife in the province. As in the case of WTP versus WTA, it is not clear which is the correct value. Kahneman and Knetsch conclude that there is no satisfactory

answer to this question. They further conclude that the reason for these anomalous results is that respondents are actually valuing the non-market commodities in terms of moral satisfaction, not in terms of the value of the commodity per se. They conclude, therefore, that CVM is fundamentally flawed as a technique for estimating economic values. Others argue that the problem relates to lack of consumer experience with the good in question, not the technique. This is a significant and recent challenge which should be closely monitored.

Given these problems, how reliable is contingent valuation? One way of answering this question is to compare CVM estimates to actual market values. Given that CVM is used to estimate non-market commodities, such comparisons are difficult. Nonetheless, a number of comparative studies have been undertaken using various valuation methods. The results summarized in Table 2 indicate reasonable convergence between results of CVM and other methods. Also interesting are the results of recent experiments (Bishop, Heberlein and Kealy, 1983; Heberlein and Bishop, 1986) in which hunters were offered real dollars for hunting permits, creating an actual market to compare to CVM results.

Mitchell and Carson (1989) and Cummings et al. (1986) caution that while such comparisons are encouraging, they are not definitive. Most comparisons are between hypothetical values estimated by alternative techniques. There is therefore no actual benchmark of market values for comparison. Second, the convergence is strong for only those goods which are well defined and with which respondents are familiar. The results are not as encouraging for less tangible goods such as clean air. Finally, the results still show significant divergence. Based on the evidence, Cummings et al. (1986) conclude that CVM estimates are accurate within plus or minus 50 percent of market values.

Table 2. Comparisons of CVM Results

Study	Commodity	Value[a] Based on CVM	Value[a] Based on Alternative Method	Alternative Method
Knetsch and Davis (1966)	Recreation days	$1.71 per household/day	$1.66 per household/day	TCM
Bishop and Heberlein (1979)	Hunting permits	$21.00 per permit	$11.00 $28.00 $45.00	TCM value of time = 0 value of time = 1/4 median income value of time = 1/2 median income
Desvousges, Smith and McGivney (1983)	Water quality improvements: a) loss of use b) boatable to fishable c) boatable to swimmable	User values:[b] average across question format)[b] $21.41 $12.26 $29.64	User Values: $82.65 $ 7.01 $14.71	TCM
Seller, Stoll and Chavas (1984)	Boat permit to: Lake Conroe Lake Liningston Lake Houston	Close-ended consumer surplus: $39.38 $35.21 $13.01	 $32.06 $102.09 $13.81	TCM
Thayer (1981)	Recreation site	Population value per household per day: $2.54	Population value per household per day: $2.04	Site substitution
Brookshire et al. (1982)	Air quality improvements: a)poor to fair b)fair to good	Monthly value[c] $14.34 $20.31	 $45.92 $59.09	HPM (property values)
Brookshire et al. (1985)	Natural hazards (earthquakes) information	$47 per month	$37 per mo.	HPM (property values)
Bishop and Heberlein (1986)	Hunting permits	$32.00	$24	cash bid

[a]Mean values among respondents.
[b]Values apply to post-iteration bids for users of the recreation sites.
[c]Values for sample population.

The foregoing discussion indicates that there are many potential problems with contingent valuation. Research shows that many of these problems can be mitigated by improving the application of the method. To improve the validity and consistency of results, the U.S. Government has published detailed guidelines for CVM studies (Water Resources Council, 1983). Subsequent to the publication of these guidelines, Cummings et al. (1986) assessed the validity of alternative approaches in a major conference. Based on their analysis, the authors suggest the following guidelines for CVM studies (Cummings et al., 1986:167):

1) Respondents must be familiar with the commodity being valued.

2) Respondents must have had prior valuation and choice experience with respect to the commodity either through direct market experience or hypothetical market experience.

3) Uncertainty regarding payment mechanisms should be minimized.

4) Willingness to pay should be employed.

Some guidelines proposed for consideration but not formally adopted by the authors are as follows (Cummings et al., 1986:231):

1) CVM value should be related to use with minimum ideological content.

2) Results should be considered unique to the payment mechanism specified.

3) CVM should exclude starting points or any other information which may influence the respondents' valuation.

4) Respondents should be given as simple a choice as possible.

5) Outliers (extreme responses) should be excluded.

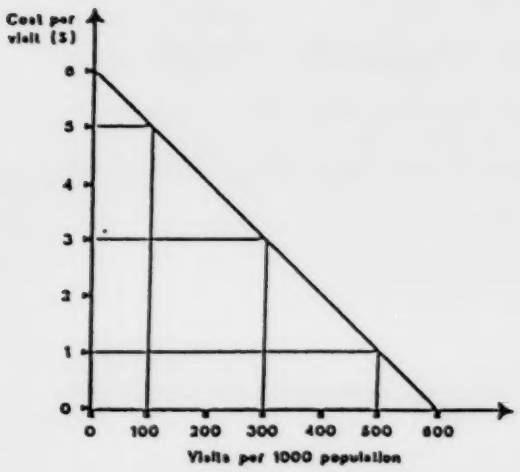
6) Subjects should view the response as an important consideration in policy making.

7.3 Travel Cost Method(TCM)

A popular alternative to CVMs is the travel cost method. The travel cost method has been refined since its initial applications in the pioneering work of Davis (1963) and Clawson and Knetsch (1966). Like CVM, it is now widely accepted in various guidelines and manuals such as the US Water Resources Council Guidelines (1983) and the British Columbia Benefit-Cost Guidelines (1977).

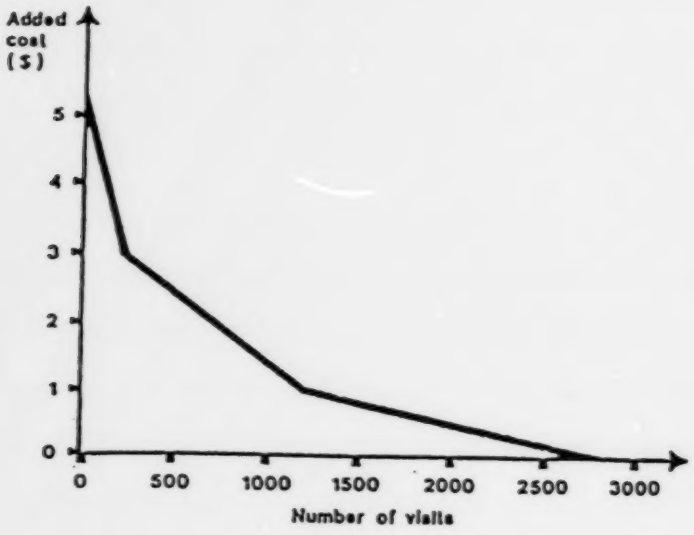
The underlying concept of the TCM is straightforward. Travellers to recreation sites incur measurable travel costs which can be used to estimate the willingness to pay for the site. The first step is to collect data on the number of visits and the origin of the visits by surveying visitors to the site. Next visitors are divided into zones of increasing travel costs, and the travel costs incurred for each zone and the number of visitors originating in each zone are estimated. A graph can then be constructed showing the relationship between cost and the number of visitors per 1000 population (Figure 2).

Figure 2. Relationship between Cost and Visits



Next, a demand curve, as illustrated in Figure 3, can be constructed by multiplying the rate of visitor participation at each price by the population in each zone. The value of the site is then estimated by the area under the demand curve.

Figure 3. Recreation Demand Curve



A principal advantage of TCM is that data on site visits necessary for calculating values are usually readily available. Consequently, the technique is relatively inexpensive to use. Second, TCM uses actual consumer expenditures to estimate non-market values thereby avoiding the hypothetical value problem of CVM.

There are several problems. First, while it is relatively easy to estimate out of pocket costs of travelling to a site, it is difficult to estimate the opportunity cost of the travellers time which must be included as part of the overall cost. Cesario (1976) concludes, based on a review of a number of studies, that the cost of time is equivalent to between one-quarter and one-half of the wage rate. Freeman (1979b) correctly observes, however, that the estimates used by Cesario are based on travel to work, results which are not applicable to

recreation travel. Indeed, studies by Sutherland (1982) and Walsh, Sanders and Loomis (1985) indicate that travel time can be a benefit improving the overall recreation experience, not a cost. Another problem noted by Bishop and Heberlein (1979) is that the wage rate overestimates the opportunity cost of time because it is unlikely that the time spent travelling to a recreation site would otherwise be spent working at the same job. The issue of appropriate travel time costs continues to be an unresolved problem which can bias estimates.

A second problem is that many recreation trips involve travel to more than one site. The problem is how to allocate the costs for each individual component of the trip. Allocation of the full costs to the recreation site would clearly bias the valuation of site benefits upward. One solution developed by Beardsley (1971) is to allocate travel costs in proportion to the amount of time spent at each site relative to the total time spent at all sites. This assumes that the benefits derived per site are equivalent to the amount of time spent. An alternative approach proposed by Haspel and Johnson (1982) is to divide the costs evenly between all destinations, with some adjustment for destinations in close proximity. One possibility is to survey visitors to assess the relative importance of each destination in their overall trip. But if surveys are used, willingness to pay questions might as well be employed.

TCM is usually employed to estimate the value of a single site. The problem is that there are often alternative sites which consumers can utilize (Freeman, 1979b). Consequently, the value of the single site can be overestimated unless alternative sites are taken into account in the valuation by using a multi-site travel cost model (McConnell, 1985).

Another problem is that TCM is limited to measuring only user benefits. Therefore, it can significantly underestimate the value of a site by excluding important non-user benefits

such as option value and existence value. Also, it is difficult to utilize TCM to estimate the impact of quality and quantity changes to the site. The costs of congestion, the benefits of facilities improvement or water quality, for example, can not be directly measured. Instead, these types of costs and benefits can only be indirectly measured by comparisons of site values as a function of site characteristics. Overall, then, TCM is not as flexible as CVM.

7.4 Hedonic Price Method

The price of a good is a function of a bundle of attributes. The value of a recreation site, for example, is a function of a number of factors such as distance, facilities, availability of recreation opportunities, environmental quality and scenic value. The difference in attributes allows for the valuation of specific features by using statistical methods to assess the impact of each individual characteristic. In effect, a site with good fishing can be compared to other sites which are similar in other respects other than the availability of good fishing. The difference in price can then be used to estimate the value of fishing.

This hedonic price method was initially developed by Griliches (1971) and Rosen (1974) to measure the value of improved quality of consumer goods. It was soon used in property value studies to estimate the impact of environmental characteristics such as air quality, noise and scenic values. Housing in areas of poor air quality, for example, is compared to similar housing in areas with better air quality to estimate the benefits of improving air quality (Harrison and Rubinfeld, 1978; Freeman, 1981). Similar studies have been done to estimate the value of improved water quality (Brown and Pullakowski, 1977), and noise. The hedonic price method has also been used in conjunction with TCM to estimate the costs and benefits of congestion, environmental quality and other site attributes (Binkley and Hanemann, 1978).

The principal advantage of the hedonic price method is that it uses actual market data to estimate non-market values. Unfortunately, it also has serious disadvantages. First, it is difficult to control for all the significant variables which affect price. Sufficient market data are often simply not available (Just, Hueth and Schmitz, 1982). Second, there are different formulations of the underlying price relationships which give different results. The actual relationship is usually unknown (Freeman, 1979c). Third, it assumes perfectly functioning markets. Consumers, however, may have insufficient information on non-market characteristics to accurately assess site attributes. Finally, expectations of future trends are capitalized into existing prices, making it difficult to isolate the effect of any individual characteristic. For these reasons, the hedonic price method has limited applicability to land use decisions.

8.0 CASE STUDY

It would now be useful to illustrate the application of the techniques through a hypothetical case study of a land use conflict in B.C. The case study is a modification of a study undertaken by the B.C. Ministry of Lands, Parks and Housing in 1979. The approach used is a multiple accounts analysis using four accounts: provincial income, regional development, environmental impact and government revenue. The procedure is summarized in Figure 4.

The values used in the case study are for general illustration purposes only and should not be interpreted to show support for any particular land use. Those wanting more detail on the issues involved in applying benefit-cost and multiple accounts to land use problems should consult Gunton (1991) and Gunton et al. (1986; 1991).

The study area is a small region in northern British Columbia of 325 square kilometers (127 sq. miles). The area is crown land most of which is forested. The study area is currently utilized for recreation but does not contain any unique features. Potential management options are as follows:

Option 1: wilderness preservation: the area is preserved for wilderness with no resource extraction

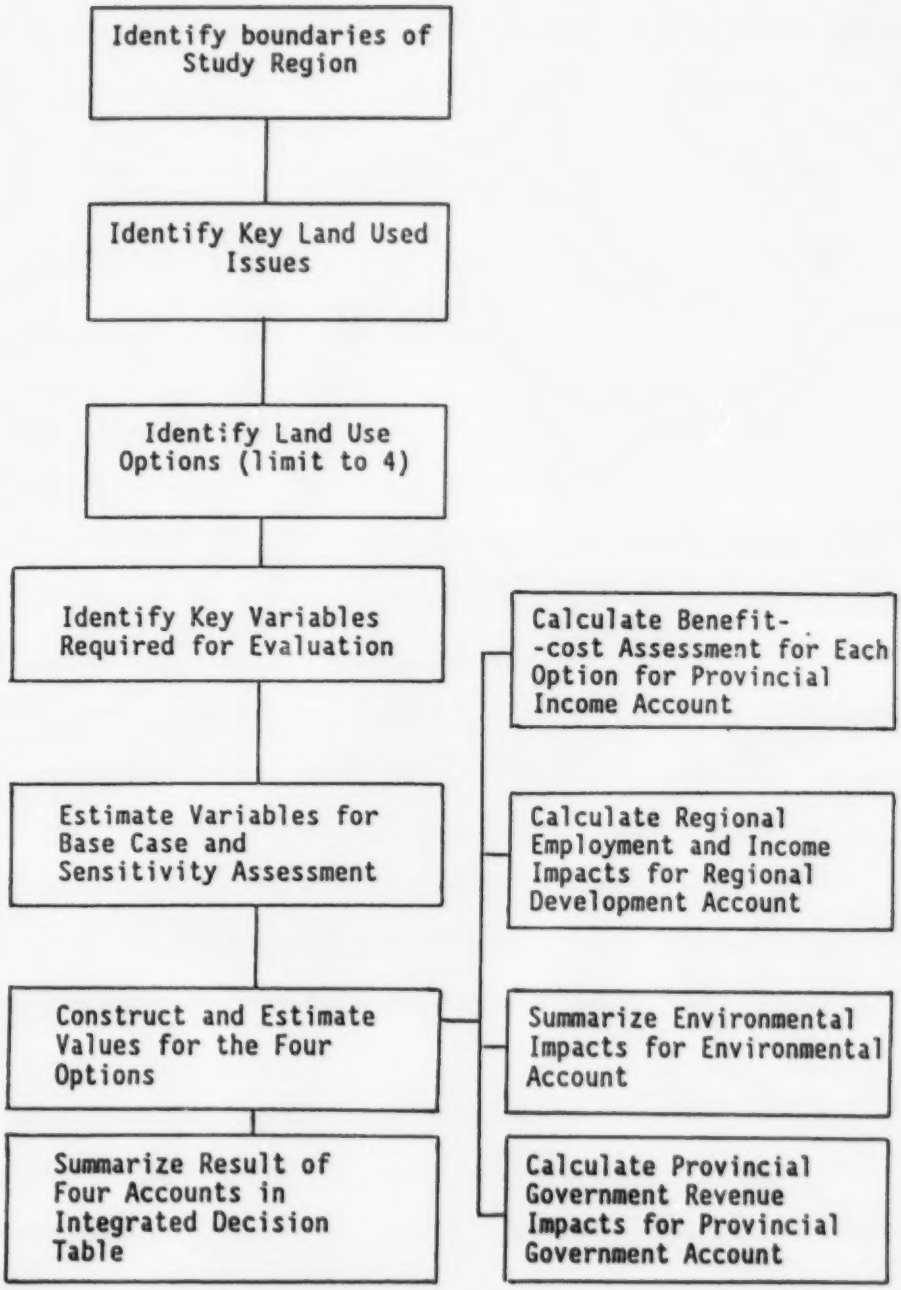
Option 2: forestry: the area is managed by the Ministry of Forests on a sustained yield basis

Option 3: agriculture: the area is sold to farmers for agricultural use.

The provincial income account is based on a benefit-cost analysis utilizing the province's benefit-cost guidelines (B.C., 1977) to estimate the net change in provincial social welfare for each option. Wilderness values are estimated by multiplying the number of user days by the willingness to pay per user day. Willingness to pay is determined on the basis of contingent valuation studies. Separate estimates are made for hunting, fishing and general hiking. Values are forecast over a 20 year period. Annual user days are forecast to increase at the same rate as population growth and willingness to pay at the same rate as the increase in per capita income. The base case estimate of wilderness value excludes preservation values and is based on willingness to pay. It should therefore be viewed as a low estimate of wilderness value. This is offset, however, by using willingness to pay estimates from other areas which may be of higher quality than the study area.

Forestry values are based on estimates of revenue and cost data forecast over the study period. Lumber prices are estimated to be the average price for the previous ten year period with no increase forecast. Costs are also estimated to remain constant over the study period. Agricultural values are based on forecast costs and revenues for the relevant products.

Figure 4


Identify boundaries of Study Region
Identify Key Land Used Issues
Identify Land Use Options (limit to 4)
Identify Key Variables Required for Evaluation
Estimate Variables for Base Case and Sensitivity Assessment
Construct and Estimate Values for the Four Options
Summarize Result of Four Accounts in Integrated Decision Table
Calculate Benefit--cost Assessment for Each Option for Provincial Income Account
Calculate Regional Employment and Income Impacts for Regional Development Account
Summarize Environmental Impacts for Environmental Account
Calculate Provincial Government Revenue Impacts for Provincial Government Account

The results of this account are presented as net present values summarized below. The results include a base case that represents the most likely value and a range of possible values based on a sensitivity analysis employing different assumptions regarding commodity prices, yields and discount rates. The increase in wilderness values to $10.5 million is based on using willingness to accept instead of willingness to pay. The lower bound of forestry benefits is based on stumpage estimates while the upper bound is based on real price increases of about 3.5% per year. The upper bound of agricultural benefits are also based on forecast real price increase of agricultural products of 3.5% per year.

The results in Table 3 illustrate how sensitive net benefit estimates are to the assumptions used. Interestingly, the range of estimates is as great for timber and agriculture as it is for wilderness. There is, it appears, as much uncertainty about so called market commodities as there is about non-market commodities.

Table 3. Provincial Income Account
(net present value in millions of constant dollars)

	Range	Base Case
Option 1 (wilderness)	$ 3.2 to 10.5	$ 3.2
Option 2 (forestry)	5.7 to 26.2	14.9
Option 3 (agriculture)	-2.2 to 6.6	-2.2

The regional development account measures the impact of the three options on regional income and employment. The estimates include only the direct impacts and exclude secondary or multiplier impacts.

Table 4. Regional Development Account

	Direct Employment to Region (# per year)	Proportion of Direct Employment accruing to region (%)	Direct Income to region (millions of $ per yr)	Proportion of total income accruing to region (%)
Option 1: wilderness	0	--	0	--
Option 2: forestry	44	100	2.2	86
Option 3: agriculture	116	69	4.1	61

The environmental account summarizes the impact of the three options on various environmental indicators in non-numerical terms. The measure is based on a scale from 1-3 with 3 being the best rating for the environmental factor. An alternative approach would be to simply list the major environmental impacts of each option. The impacts of forestry depend very much on harvesting methods. More restrictive forest practices to protect habitat could reduce negative impacts while possibly increasing harvesting costs.

Table 5. Environmental Account

Environmental measure	Option 1 Wilderness	Option 2 Forestry	Option 3 Agriculture
Game population	3	3	1
Winter habitat	3	2	1
Active user aesthetics	3	2	1
Casual user aesthetics	3	3	2
Fish diversity	3	3	1
Game diversity	3	2	1
Fish habitat	3	2	2
Water quality	3	2	1
Air quality	3	3	3
Total score	27	22	13

The government revenue and expenditure account estimates the impact of the land use options on net government revenue. The structure of this account is conceptually more difficult than the other accounts because it is difficult to estimate net provincial revenue impacts. Net provincial revenue estimates should incorporate the concept of opportunity cost. If the resources are not employed in the proposed project, they will be employed elsewhere in the economy, thereby generating government revenue. For the economy as a whole, the net gain in revenue is only that above what is generated in the alternative "normal" project. Therefore, only tax revenue above that generated in a "normal" project such as special resource and land taxes should be identified as incremental revenue gains. For a small provincial economy, some proportion of the resources employed in the project may be utilized in other projects outside the province. This revenue decline, however, is offset by a decline in government expenditures resulting from the decline in provincial demand for services. In practice it is very difficult to estimate these impacts due to lags in migration patterns and uncertainty in public cost and revenue estimates. Consequently, net revenue impacts should be interpreted cautiously.

The revenue impacts estimated for the three options are summarized in Table 6. Net revenue estimates are calculated by subtracting direct expenditures associated with the management option from resource and land tax revenues and lease and sale revenue. Corporate and personal income tax are shown but not included as incremental revenue because these are normal taxes which would be generated in alternative projects and are offset by normal expenditures such as health and education which are also excluded in the estimate of net revenue impacts.

Table 6. Government Revenue and Expenditure Account
(Net present value in millions of $)

	Option 1 Wilderness	Option 2 Forestry	Option 3 Agriculture
Corporate Income Taxes	Nil	1.3	5.7
Personal Income Taxes	Nil	0.5	1.9
Resource and Land Taxes	Nil	6.9	3.9
Revenue from Lease or Sale of Land	Nil	Nil	11.3
Expenditures	Minimal	(.3)	(8.0)
Net Revenue Impact	Nil	6.3	7.2

Table 7. Integrated Analysis

	Option 1 Wilderness	Option 2 Forestry	Option 3 Agriculture
Provincial Income (net present value in millions of $)	3.2	14.9	(2.2)
Regional Development			
a) direct permanent jobs in region	0	44	116
b) direct income in region (millions of $ per year)	0	2.2	4.1
Net Provincial Government Revenue (net present value in millions of $)	0	6.3	7.2
Environmental Impact Score (from 9 to 27 points)	27	22	13

The results of the four account analysis can now be summarized for decision makers (Table 7). The results indicate that the key tradeoff is between intangible environmental values maximized in the wilderness option, economic development options maximized in the agricultural option, and efficiency values maximized in the forestry option. The preferred option depends on the weights given to these values by the various interests involved. The analysis provides information helpful for understanding the tradeoffs involved.

9.0 CONCLUSION

Sound decision making depends on incorporation of environmental, social and economic values into the evaluation process. This report has reviewed four economic techniques for evaluating environmental policy: benefit-cost, cost effectiveness, economic impact and multiple objective analysis. The principal advantage of benefit-cost analysis is that it incorporates many relevant factors into a consistent analytical framework based on common units of measurement which can be summed to provide an overall assessment for the purposes of decision making. The principal disadvantages are that benefit-cost is based on a decision calculus in which one dollar equals one vote, it does not explicitly include variables important to decision makers such as employment and equity and it cannot provide adequate dollar measures for many important environmental impacts. Also, the uncertainty associated with determining quantitative values for relevant variables necessitates extensive sensitivity analysis utilizing different assumptions. This results in a wide range of possible estimates of net benefits with no clear indication of which is correct. At best, benefit-cost simply provides a reasonable range of possible outcomes.

Cost effectiveness is a variant of benefit-cost in which benefits are quantified in non-dollar units and costs in dollar units. This overcomes the problem of estimating appropriate dollar values while still identifying the least cost option for achieving the desired objective. The problem is that cost effectiveness does not indicate whether the policy objective is desirable or not.

Economic impact analysis can be used to evaluate the impact of options on selected economic indicators such as employment, government revenue and economic output. Decision makers often view such information as highly significant in their evaluation. Economic impact assessment is, however, one of the most abused methods of evaluation. It is often assumed that all jobs are incremental and that job generation alone is sufficient justification for undertaking a project. Economic impact assessment is a useful component of evaluation but on its own is insufficient.

Multiple objective analysis was developed in response to the criticism of other techniques. In effect, it combines other methods into an integrated framework thereby retaining the advantages of each technique while mitigating many disadvantages. Multiple objective analysis explicitly includes intangibles, it is flexible enough to include all relevant variables, it displays assumptions clearly and it disaggregates impacts so that each decision maker can apply his/her own weight to the relevant variables. The disadvantages are that it is time consuming and expensive. Also, it does not utilize a single summary index to assess the project. However, given that there is no such thing as a satisfactory summary index, this is not a serious disadvantage.

This report also shows that there is wide spread acceptance of techniques for assessing non-market values. There are, however, problems with reliability of the non-market estimates.

While some of these problems can be mitigated by appropriate use of the technique, there remain more fundamental questions about the validity of some approaches.

The overall conclusion of this report is that economic evaluation can improve resource and environmental management in B.C. To this end, the following recommendations are made.

1) Decision making is fundamentally a question of values. Economic evaluation techniques can improve decision making by providing information on impacts but it cannot resolve differences in values. Consequently, economic evaluation must be complemented by institutional structures that allow for broad public involvement and constructive dispute resolution in the decision making process. Economic evaluation is only an aid in the decision making process. Therefore, expectations of its ability to help resolve disputes should be modest.

2) Economic evaluation is underused in B.C. There are no requirements for comprehensive economic evaluation of major projects and policies. When economic evaluation is undertaken, there is considerable diversity in approaches and assumptions. Therefore, requirements for economic and environmental assessment of major projects should be instituted in B.C., and guidelines on accepted use of techniques should be prepared to ensure consistent and reliable results.

3) Multiple Accounts Analysis (MAA) is the most comprehensive technique available. It effectively combines the advantages of other approaches. Therefore, the development of guidelines in B.C. should be based on the MAA process used by the U.S. Water Resources Council. The guidelines should provide direction on all major issues such as discount rates, valuation of intangibles, use of shadow pricing and other key assumptions. The guidelines could be based in part on updating the provincial benefit-cost guidelines.

4) The application of MAA can be a lengthy and costly process. To assist in implementation, geographical information systems such as the B.C. TRIM model should be integrated with the Ministry of Forests growth-yield model and the Ministry of Finance input-output model. Such integration would allow for rapid and inexpensive interactive analysis of land use conflicts. These models already are operational and their integration would be relatively simple.

5) The province should undertake non-market studies of important environmental values to establish data necessary for economic analysis. It should be acknowledged, however, that many important environmental values cannot be quantified in dollars and should be left as intangibles explicitly stated in the analysis but not in dollar terms.

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APPENDIX 1

SUPPORTING TABLES

Table 1

Mean priority ratings of regional public representatives for aggregate objectives in respect to the use of forests in British Columbia

Objective	Significant differences	Total Sample	Vanc.	Prince Rupert	Prince George	Kamloops	Nelson	Cariboo
Generate revenue	NS	17.2	18.8	16.7	14.7	17.6	11.3	25.6
Maintain healthy environment	p=.0404	23.2	27.4	25.4	15.3	21.9	30.1	16.9
Maintain forest as a renewable source of timber	NS	25.9	23.2	25.3	31.3	26.0	22.6	25.0
Generate development opportunities	NS	10.6	8.0	13.7	13.9	10.5	9.3	11.3
Meet political considerations	NS	7.5	8.8	3.7	7.5	9.3	9.0	8.1
Generate employment	NS	15.1	13.8	15.1	17.3	14.8	17.7	13.1

NS = no statistically significant differences between regions

Source: Vertinsky et al. (1990).

Table 2: The Treatment of Timber Values in Selected Forest Land Use Studies

Name	*Study Area*	*Values Used*	*Methodology*	*Comments*
British Columbia Ministry of Environment and Ministry of Forests (1983)	Reserving old growth timber stands to preserve deer and elk habitat on North Vancouver Island Examines five options differing in the amount of winter range provided for deer and elk.	Costs of providing winter ranges (foregone timber benefits) (1982$): $9.80/$m^3$ stumpage $0.45/$m^3$ annual rent $3.75/$m^3$ wage cost $1.20/$m^3$ corp. income tax $0.80/$m^3$ logging taxes $16.00/$m^3$ total 10% discount rate is used.	- calculate reduction in AAC(m^3) for each land use option. - multiply this value by the costs per m^3 to obtain annual costs of foregone timber harvests due to each option. -the $3.75/$m^3$ wage cost is an estimate of the amount by which earnings in the forest sector exceed the opportunity cost of employing that labour. It is calculated by taking 15% of the wage in the manufacturing forest sector (given to be $25/$m^3$). - calculates direct jobs lost for each option (no methodology given). Discounting: - break up future into two bits for benefits: the "present" (1982-2001), and the "future" (2001-2021), for the calculation of present value of benefits of hunting (ie. they discount only the "future" period). - to get the present value of costs, the usual discounting procedure is used (ie. on an annual basis).	- use computer simulations to project future deer populations and future timber harvests. - no attempt is made to value the loss of the right to secure tenure over harvesting timber stands. - does not calculate "shadow price" for foreign exchange earnings. A strange discounting procedure is used. Benefits are treated in a much more favourable way than costs are. In effect the first 20 years of benefits are not discounted at all. Only the years 2001-2021 are discounted back to 1982. Even so, they still arrive at a net present value of each option with costs strongly outweighing the benefits of habitat protection. Do not estimate the costs associated with the provision of forage areas.

Table 2: The Treatment of Timber Values in Selected Forest Land Use Studies, cont'd

Name	*Study Area*	*Values Used*	*Methodology*	*Comments*
British Columbia Ministry of Forests, Strategic Studies Branch (1983)	Impact Analysis of the cost of establishing deer and elk reserves on TFL37 and 39	Direct economic cost of foregoing timber harvests (1982$): $120/$m^3$ is the value of shipments by forest industry 1973-81 avg wage and salary benefits are: $15/$m^3$ logging $27/$m^3$ wood &paper &allied $42/$m^3$. provincial government benefits: $9.50/$m^3$ stumpage(1972-81 avg.) $1.45/$m^3$ royalty(1979-82) $6.70/$m^3$ TL stumpage & royalty (1977-81) $0.33/$m^3$ annual rent $0.80/$m^3$ logging tax(1972-82) $1.20/$m^3$ corp inc tax (1971-79) $1.10/$m^3$ social service tax (1971-79) $2/$m^3$ personal inc tax (1971-79) $0.60/$m^3$ social service tax on personal inc (1974-77) No discounting.	Employment effects are given by: 0.7 person-years(py) of direct employment in harvesting and managing TFL 37 for each 1000m^3 harvested (from Canadian Forest Products Ltd. 1972-81 avg). This number is also used for TFL 39. Statistics Canada data implies the following values for employment effects in other forest industries: sawmills and planing mills: 0.51py per 1000m^3 harvested on coast (1978-80 avg). plywood and veneer: 0.2py per 1000m^3 (1971-80 avg) pulp&paper: 0.4py per 1000m^3 (1971-80 avg) $\Rightarrow$1.1 person-years of employment in wood processing for each 1000m^3 harvested on the coast. $\Rightarrow$total direct employment in forest industries is 1.8py/1000$m^3$of timber harvested. Indirect and induced employment is 2 times direct employment.(from FCL Reed & Associates Ltd.,1975) The amount of timber harvest lost under each option is estimated to use with the above values in the calculation of the effects of each range reserve option.	Although indirect and induced employment effects are calculated, values are only given for direct employment effects in the analysis. (ie. they indicate the number of indirect and induced jobs lost but they are not included in the cost calculation) The analysis is only carried out for a "representative" year. There is no treatment of the time path of impacts. Contains no attempt to value non-market benefits or costs.

Table 2: The Treatment of Timber Values in Selected Forest Land Use Studies, cont'd

Name	*Study Area*	*Values Used*	*Methodology*	*Comments*
Bowden (1986)	Stein Valley, BC Examines two alternative developments: wilderness and mixed use.	Timber benefits (1986$): Revenue from timber: Lumber: Low $45/$m^3$ Mid $51/$m^3$ High $57/$m^3$ Chips: $10/$m^3$ Timber costs (1986$): Logging and hauling costs: $31.38/$m^3$ Milling costs: $26.72/$m^3$ Minstry of Forests costs: $1.00 per hectare of operable forest land. Harvests are assumed to be 110,000m^3 /year.	High price of lumber taken from Gunton et. al.(1985). Low price is average of Gunton, et. als. low and medium prices. Medium price is the average of the resulting low and high prices. Chips price is taken from Gunton et. al.(1985). Logging, hauling and milling costs are weighted averages of the costs from BCFP(1986) and Lytton Lumber (1985). Ministry of Forest costs are variable costs only (related to the Stein) and exclude reforestation costs.(citation unclear)	In addition to the "basic" economic analysis (based on actual cash payments), Bowden discusses several economic adjustments. He does not actually apply these adjustments to his calculations. If unemployment exists, actual cash payments to labour exceed the opportunity cost of labour. Gunton et. al.(1985) calculates that inclusion of this effect would reduce PV of estimated costs by $4.9 million(at a 10% discount rate), which is quite significant depending on the price scenario. Can also "shadow price" foreign exchange earnings. Bowden provides a crude estimate of benefits to be 4% of foreign exchange earnings ($300,000/year). He mentions that by using the "AAC effect" harvest benefits may be treated as occuring in the present rather than when they actually occur. He mentions an employment multiplier of 3 and a GDP multiplier of 2.5-3. He also mentions government revenues of $1.60/$m^3$ stumpage, $0.25/$m^3$ annual rent for allocated AAC, and $2.00/$m^3$ harvested personal income tax. He does not incorporate these values into his analysis.

Table 2: The Treatment of Timber Values in Selected Forest Land Use Studies, cont'd

MacMillan Bloedel (no date given - presumably 1983)	Response to MoE/MoF reports	They maintain that forestry values are understated. Forage area costs can and must be estimated. Costs associated with modifying current logging plans should be included. MB figures these additions would increase costs of foregone logging by 60% using the 10% discount rate. They take issue with the $\$3.75/m^3$ figure for the cost of foregone wage and salary benefits. Since wages are higher on the coast, a basic wage and salary cost of $\$33.50/m^3$ should be used. To this should be added employment benefits of 15% of wages and salaries. Therefore, the true manufacturing employment cost is $\$5.78/m^3$. They also maintain that logging employment costs should be included as any re-employment is likely to be at a lower wage. Thus, they get a total employment cost of $\$9.18/m^3$ instead of $\$3.75/m^3$ in B.C. MoE&MoF (1983) They feel that foreign exchange benefits of $\$4.00/m^3$ (MoF estimate) should be included. They suggest not discounting future net benefits. Instead just look at costs and benefits occurring in an average year.

Table 2: The Treatment of Timber Values in Selected Forest Land Use Studies, cont'd

Name	*Study Area*	*Values Used*	*Methodology*	*Comments*
Pope (1986)	BC - West Coast Trail Wilderness vs mixed logging/wilderness uses.	Discount rate (R) is 8% (10% for sensitivity analysis) Wage differential, WD, is set equal to zero for the base case,and \$6.66/m^3 for sensitivity analysis. Timber harvest volume,VOL, equals 527m^3 /ha for coastal areas, and 681m^3 /ha for inland areas. Silviculture costs, SILV, are taken to be \$1106/ha all values in 1983\$ deflated with GNP price index.	Total timber benefits (TBT) are given by: $TBT = \sum_{T=1}^{50} (WD \cdot VOL + STUMP)/(1+R)^T$ WD=\$/m^3 wage differential between forestry and all manufacturing sectors. WD is set to 0 for the base case and a sensitivity analysis is done with it set at \$6.66/m^3 The number is derived from average percentage wage differential over 1979-84 based on average weekly earnings for BC employees in the relevant sectors (from Statistics Canada). Using June 1983 weekly earnings and the 1977-81 average of 1.75 person-years per 1000m^3 harvested in coastal BC (BC MoF, Vancouver Region, 1985) she gets \$6.66/m^3 . STUMP=market value of timber(logs) less the cost of harvesting. Since this fluctuates a lot, she uses 10 year average (1974-83) of stumpage rates for various grades. VOL= scaled volume of timber harvested annually from the area Timber costs (those costs excluded from stumpage): $TCT = \sum_{T=1}^{50} (SILV \cdot HA)/(1+R)^T$ SILV= average silvicultural costs per hectare. Derive this from average costs per hectare of each silvicultural activity for Vancouver Forest Region from Jones' (1983) compilation. Assumes 82% of land logged gets treated (from MB on TFL 44). For each treatment the degree to which it is used was calculated as a percentage of the total area surveyed from annual reports (BC MoF Vanc. Region, 1985). Assumes average silvicultural cost would apply to 1/50 of the area each year. HA= number of hectares logged annually.	She only examines market benefits and costs. Assumes silvicultural intensity will not change over the 50 year horizon.

Table 2: The Treatment of Timber Values in Selected Forest Land Use Studies, cont'd

Name	*Study Area*	*Values Used*	*Methodology*	*Comments*
SFU-NRM Report no. 6 (1990)	BC Calculates the effects of implementation of the Vahalla Society proposals for wilderness preservation	Fiscal Impacts: $10.49/m^3 expected ten year average stumpage rate, coast $8.38/m^3 expected ten year average stumpage rate, interior. Average provincial corporate income tax paid as a percentage of the net value of shipments (1979-86 avg): Logging 0.61% Wood Products 0.79% Paper&Allied 0.70% Effective sales tax rate on gross labour income = 1.8% Effective personal income tax rate on gross labour income = 6.94% All values are in 1988$.	The value of forest products is calculated via a complicated formula. Forest industry expenditures are presented for aggregate catogories (wages and salaries, fuel and electricity, and materials and supplies) Employment effects are also presented. They are derived from average annual income for workers in each sector divided by the projected decrease in wages and salaries expenditure to give the number of workers potentially affected. Multipliers are used to give indirect and induced employment effects. Stumpage calculation is given by: IR = BR + (VI - **VI**) IR=stumpage rate BR=base rate for coast or interior (set by provincial government) VI=value index for area being cut (difference between estimated selling price for the timber and the costs associated with bringing it to market) **VI** = mean value index for coast or interior (average of value indices for all timber harvested in a region over a given period of time). Disagregates corporate income tax data using method of Howard (1978).	Restrict fiscal analysis to provincial government revenues only, no attempt to quantify local government revenues. Assumes removal of lands from forest base results in an immediate reduction in AAC (ie. worst case scenario) No discounting of benefits or costs is done. They simply calculate impacts without regard to the point in time at which they occur. Non-fiscal impacts are presented in aggragate fashion only.
Heaps (1985)	*An Analysis of the Present Value of Stumpage under a Variety of Economic and Management Conditions*	5% discount rate in base case	Timber value: Calculates soil expectation value by: SE=(STUMP-STC)/(EXP(RxA)-1)-STC where A=rotation length, R=discount rate, STC=site treatment cost. STUMP=$(1+I)^{-1}$REV-COST is the Rothory formula. He maximizes this by choice of A. Assumes real revenues and costs are constant far into the future. This is a problem since the share of high value old logs will diminish as second growth timber is used.	This calculation is made in the context of deriving the optimal rotation length through maximization of soil expectation value.

Table 3: The Treatment of Recreation Values in Selected Forest Land Use Studies

Name	*Study Area*	*Values used*	*Source*	*Comments*
British Columbia Ministry of Environment and Ministry of Forests (1983)	B.C.- North Vancouver Island	Hunting benefits are: $27.50/hunter-day for deer $95.00/hunter-day for elk A threshold of 5 deer/sq.km is defined to be the recreationally useable population level (no source) Number of hunter days is found by multiplying the estimated annual harvest by the average hunter success rate which is: 12.5 hunter days/kill for deer (1976-81 avg) and 6.7 hunter days/kill for elk (1979-81 avg) Values are expressed in 1982 dollars. 10% discount rate is used.	Pearse-Bowden (1977) report (deer) McDaniels (1980) report (elk)	-use a wildlife model to estimate impact of various winter range programs on the number of deer and elk which can be maintained. This implies the level of hunting which can be maintained and, thus, the level of hunting benefits. - the threshold deer population requirement indicates the study is more of a cost-effectiveness one. -does not treat wolf predation effects and cost of wolf control. -does not treat effects on other wildlife species. - no attempt to measure option/existence benefits or non-consumptive use benefits. The authors mention that since they only measure direct consumptive use of the deer and elk that the benefits are understated. However, no attempt is made to state by how much they are understated and whether or not inclusion of other benefits could cause positive NPV of any reserves.
Bowden (1986)	B.C.- Stein Valley	Recreation values: $36.00/day for hunting $24.00 /day for fishing $5.00/day for day-hiking $15.00/day for backpacking and guided tours Measured in1986$ Uses 0, 8, 10% discount rates.	Gunton et al (1985) for values and activity levels for first three activities and the value of the fourth. Copeland (1985) for activity levels for backpacking and guided tours.	- costs of providing the recreational uses are omitted, rather than including an "arbitrary" cost estimate. - values come from Gunton et al and are regional averages of WTP. WTP is correct since recreation levels are not being realized at the present. (Gunton et. al. use willingness to sell determined by multiplying willingness to pay data by 3.25). - values are constant through time. -no attempt is made to quantify any redirection of recreation users from other areas to the Stein if the Wilderness option chosen. - indicates existence of a quality/accessibility tradeoff in estimating the value of the recreational opportunity (ie. logging roads allow access to remote areas). - referent group is taken to be the province of BC. It is assumed that all benefits from hunting and fishing accrue to BC residents and 80% of benefits from day hiking, backpacking and guided tours accrue to BC residents.

Table 3: The Treatment of Recreation Values in Selected Forest Land Use Studies, cont'd

Name	*Study Area*	*Values used*	*Source*	*Comments*
Popo (1986)	B.C. - West Coast Trail Three alternatives: Wilderness Multiple Use Logging	Recreation values: $45.44/day for wilderness hiking (wilderness alternative) $16.96/day for dispersed recreation (day-hiking - Multiple use alternative) $140,000/year cost to Parks Canada of operating West Coast Trail All values in 1983$ Uses 8, 10% discount rates.	U.S. Water Resources Council	- got value from WTP figures of U.S. Water Resources Council and multiplied them by 3.3 to get compensation demanded, which is used because the trail is already in use. - number of user days estimated from Parks Canada data (no particulars) - assumes that the growth in user days will be the same as BC population growth over the period 1981-2002. - no incorporation of carrying capacity (crowding effects may be important, especially to the Wilderness option). - no attempt is made to measure preservation value.
Phillips et. al. (1989)	Alberta - wildlife values	Consumptive recreation values: (benefits/person/year) $204.06 for big game hunting $151.12 for grizzly bear hunting All values in 1989$ Uses 5, 8% discount rates.	Contingent valuation study.	-the numbers represent average responses, but median responses are also calculated. The justification for the use of median values would be majority voting rules. -do not calculate non-consumptive benefits.
Pattison (1970)	Alberta - moose hunting	Consumptive recreation values: $4.13/person/day for residents $11.99/person/day for non-residents $5.45/person/day for all hunters	Contingent valuation 1968 data	-estimates daily and yearly Extra Market Benefits captured by resident and non-resident Alberta moose hunters using data from Big Game Zone 1 in northern Alberta.
Miller (1971)	Alberta - hunting	Consumptive recreation values: resident: $9.40/person/day in 1968 $8.33/person/day in 1969 non-resident: $18.04/person/day in 1968 $11.52/person/day in 1969	Contingent valuation 1968 data from 15 big game zones, 6 waterfowl zones and 5 upland bird zones	- "Extra Market Benefits" represent more than 75% of total social net benefits for resident hunters in this study.

Table 3: The Treatment of Recreation Values in Selected Forest Land Use Studies, cont'd

Name	*Study Area*	*Values used*	*Source*	*Comments*
Prather (1974)	Alberta - hunting	Consumptive recreation values: CVM: $10.45/person/day for residents $16.08/person/day for non-residents TCM: $6.08/person/day for residents $16.80/person/day for non-residents	Contingent valuation and Travel cost studies 1969 data from 9 big game zones	-use data from 9 big game zones to infer benefits to Alberta hunters.
Phillips, DePape and Ewanyk (1977)	Alberta - total and Oil Sands Area - hunting	Consumptive recreation values: residents(nonresidents): $31.58(54.97)/person/day big game $21.60(38.68)/person/day bird game $33.24(48.48)/person/day all game	Contingent valuation 1976 data	
Adamowicz (1983)	Alberta - East Slopes - hunting	Consumptive recreation values: resident(nonresident) $72.94(246.53)/person/day mountain sheep $72.01(93.38)/person/day moose $70.48(116.67)/person/day grizzly bear $68.04(NA)/person/ day mountain goat $63(61.50)/person/day elk $53.20(37.08)/person/day black bear	Contingent valuation 1981 data	

Table 3: The Treatment of Recreation Values in Selected Forest Land Use Studies, cont'd

Name	*Study Area*	*Values used*	*Source*	*Comments*
Bodden and Lee (1986)	Alberta - resident pheasant hunting	Consumptive recreation values: CVM: $17.44/person/day TCM: $25.37/person/day	Contingent valuation and Travel cost 1985 data from south Alberta	
Heaps (1985)	Selected parks in B.C. - Alice lake - Cultus lake - Mount Seymour - Cypress Bowl	$4 mean social value per user day of recreation. Measured in 1979$ 5% discount rate used in base case	Griffen (1984) derives social value of recreation from estimated demand functions for recreation days for 3 of these parks.	Examines a way to allow for non-timber benefits in the maximization of stumpage (or calculation of optimal rotations). He found a weight for wilderness values such that maximum timber plus non-timber values required a rotation period of at least 100 years. This implies non-timber value of $400/yr/ha for a 100 year old stand. This provides a threshold level of non-timber benefits above which the forest stand should not be logged. From parks data he calculates visits/hectare/year for four parks. Using Griffen's value per day number he derives social values of recreation per hectare per year: Alice Lake $1000 Cultus Lake $1160 Mount Seymour $220 Cypress Bowl $600 Thus, Alice Lake, Cultus Lake and Cypress Bowl should be kept as parks. If visual aesthetic values are included, Mount Seymour would probably make the scratch also.

Table 4: Adjusting for the Timing of Benefits and Costs in Social Decision Making

Discount Rate	*Particulars*
0%	The idea of forest rent as used in 18th century Europe as the basis for tax collection did not consider any interest on the capital embodied in the forest (Gane, 1968). The idea was later reintroduced by Shepard(1925).
3%	This "real" interest rate is used by Hynard(1986). It corresponds to the long-term difference between market interest rates and inflation.
3%	This is based on a study of the real rate of return on long-term Government of Canada bonds by Reuber and Wonnacott (1961). This same figure was found for the period 1956-1977 in a Wood Gundy study (1977).
3%,5%,8%	These values are used in the benefit/cost analyses of Ontario reforestation investment by Anderson (1979).
4%	This value was used by von Gehren (1849) and Faustman (1849) in their model of discounted cash flow for forest lands.
4%	U.S. Forest Service's recommended rate based on work by Row, et. al. (1981).
5%,10%,15%	This is the range of values suggested by Canadian Federal Treasury Board Guidelines (1976)
6%	During 1956-73 this figure was the average expected real yield on Canadian equities traded on the Toronto Stock Exchange (Wood Gundy, 1977)
6%	This is the return, before tax and after inflation, on a diversified portfolio of stocks between 1871 and 1973 (Bernstein 1974)
6%	This is the real historical return, after tax and after inflation, on corporate capital (Nordhaus 1974)
7-8%	In the period 1973-1976 expected real yields on Canadian equities increased to this level (Wood Gundy 1977). The real supply price of capital in Canada was in this range during 1955-1972 (Helliwell et. al.1973)

Table 4: Adjusting for the Timing of Benefits and Costs in Social Decision Making, cont'd

7-15%	Mishan (1976) argues that the discount rate should reflect only the highest rates of return on private investment.
8%, 10%, 12%	Recommended rate for B.C. cost benefit analysis from the Environmental and Land Use Committee Secretariat (Loose ((1977)).
9.5%	This is the average overall rate of return on private investment in the Canadian economy. This figure is the result of an empirical study by Jenkins (1972) of the financial statements of numerous Canadian industries during 1965-1969. This number is what promted Treasury boards across Canada to choose 10% for use as the social discount rate. The following four studies represent reactions/alternatives to Jenkins' approach.
7%	Burgess (1981) argues that the elasticities used by Jenkins to weight the various industries were incorrect. The 7% number comes from using Jenkins' model with the "correct" elasticities.
6.5%	Boadway et. al. (1984) estimate social discount rate based on rates of return in financial markets instead of accounting data. They also incorporate various taxes. They use data for the period 1963-1971.
6.6%	Spiro (1987) modified Boadway et. al. to get this number. He modified it by incorporating more tax effects.
3-5%	Heaps and Pratt (1989) make some adjustments to above calculations. They argue that a risk-free rate should be used. Risk and uncertainty should be treated directly using Expected Net Present Value. Also note that estimates of consumption rate of interest is around 3% which then forms a lower bound on the social discount rate.

Table 4: Adjusting for the Timing of Benefits and Costs in Social Decision Making, cont'd

Specifically applied to forestry

Name	*Study*	*Methology*	*Comments*
British columbia Ministry of Environment and Ministry of Forests (1983)	Reserving old growth timber stands to preserve deer and elk habitat on North Vancouver Island Examines five options differing in the amount of winter range provided for deer and elk.	Discounting: - break up future into two bits: the "present" (1982-2001), and the "future" (2001-2021), for the calculation of present value of benefits of hunting (ie. they discount only the "future" period). - to get PV of costs, the usual discounting procedure is used (ie. on an annual basis).	Benefits are treated in a much more favourable way than costs are. In effect the first 20 years of benefits are not discounted at all. Only the years 2001-2021 are discounted back to 1982. Even so, they still arrive at a net present value of each option with costs strongly outweighing the benefits of habitat protection.
British Columbia Ministry of Forests, Strategic Studies Branch (1983)	Impact analysis of the cost of establishing deer and elk reserves on TFL37 and 39	No discounting done. Impact analysis only, ie. they only look at impacts per volume of wood harvest lost.	
MacMillan Bloedel (1983)	Response to MoF and MoE&MoF studies	"The problems associated with selection of and acceptable discount rate and the failure to clearly present the costs and benefits that are incurred each year necessitate an alternative way of presenting the values. A suggested method is to view the costs and benefits that will occur in an average year." (p. 20) They use average hunter days per year and volume in m^3 of foregone timber harvest multiplied by their average unit values to get net benefits for each alternative in a representative year.	
Pope (1986)	BC West Coast Trail	Uses discount rate of 8%, 10% used for sensitivity analysis, following the recommendations of Loose (1977) in Guidelines for Cost-Benefit Analysis. The rate is used to discount total net benefits from timber harvesting, and silvicultural costs (separately), assuming silvicultural insensity will not change over the 50 year time horizon.	

Table 4: Adjusting for the Timing of Benefits and Costs in Social Decision Making, cont'd

Name	*Study*	*Methology*	*Comments*
Heaps (1985)	*An Analysis of the Present Value of Stumpage under a Variety of Economic and Management Conditions*	Uses a 5% discount rate in the calculation of soil expectation values. To get this number he follows methodology recommended in Row et al (1981) which underlies the US Forest Service's recommended rate of 4%. His view is that discount rates used in forestry investment analysis should reflect risks associated with forestry. These risks are quite low when diversified over a large number of stands. Thus, he accepts the calculation of Row et al (1981) and rejects that of Jenkins (1980) which recommends 10% discount rate for public projects in Canada He calculates his 5% rate by using the average rate of return on AAA corporate bonds (believed to be relatively risk-free) with an upward adjustment to reflect loss of taxes from the foregone private investment.	
Bowden (1986)	Development alternatives for the Stein Valley in BC	Uses discount rates of 8%, 10% (and 0% for "illustrative" purposes) to discount net benefits of the alterative developments. No comment is made as to where these came from. Values used for wilderness uses are assumed constant through time.	
Loose (1977)	*Guidelines for Cost-Benefit Analysis* (B.C. Environmental and Land Use Committee Secretariat guidlines)	The correct measure to use is the social opportunity cost of capital. Two parts to guideline for discount rates: (i) Use a weighted average private sector rate of return where the weights are the proportions of total financing for the project which are diverted from each sector of the economy (the province in this case). Find out the proportion of funds diverted from other potential investments in given sectors within the province and use these to weight the rates of return calculated by Jenkins (1972) for Canada. (ii) If sectoral detail cannot be obtained, should use 10%, with 8% and 12% used for sensitivity analysis (if desired).	In choosing the opportunity cost of capital as the correct concept he cites the following problems with the social rate of time preference idea: - the degree to which intergenerational efficiency should govern public policy cannot even be determined at the political level. - politicians elected by the present members of society cannot determine what is best for future generations. - nor can politicians determine what future generations want without knowledge of their aggregate individual preference functions. Therefore, for practical reasons, analysis must proceed largely on the assumption that economic efficiency is the primary basis for the determation of the discount rate.

Source: W.T. Stanbury, Dr. Ilan Vertinsky, and H. Thille. The Use of Cost Benefit Analysis to Allocate Forest Lands Among Alternative Uses. Forest Resources Commission, Background Papers. Volume 2. Victoria B.C. 1991

Vern A. Burkhardt
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